LONGWAVE AND WINDOW ADMS FOR OVERCAST AND CLEAR SKY SCENES

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METHOD OF GENERATING ADMs

- Radiance measurements from CERES SSFs (68 RAPS + 9 AT days) are composited into VZA ranges and fixed percentile intervals of selected parameters (e.g. PW, IR emissivity, etc.)

- Compute mean radiances for each combination of parameters.

- To fill in empty bins, use theoretical LW ADMs (Gupta LW Model). Determine theoretical model whose radiance ratio matrix is closest to the observed radiance ratio matrix.

- Estimate observed radiance from missing angular bins from theoretical model radiance ratios and observed radiances in the sampled bins.

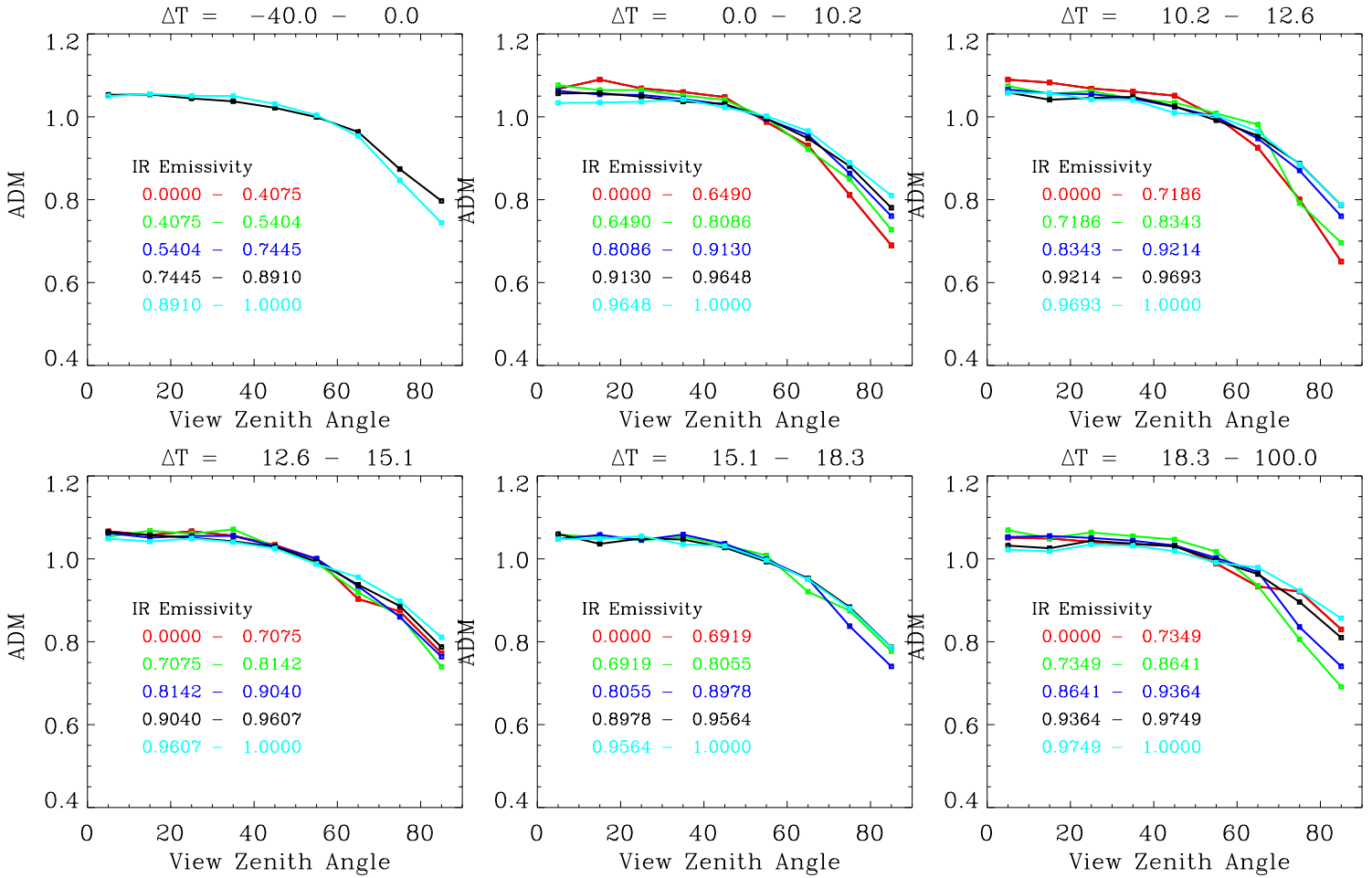
Potential CERES Longwave and Window ADM Scene Types (Overcast and Clear Sky)

Cloud Amount(%)	Clear (cldf = 0%) Overcast (cldf =>99%)
Surface Type	Ocean, Land
Precipitable Water	0-33.3, 33.3 - 66.6, >66.6 Percentile Intervals
Cloud Particle Phase	Water, Mixed, Ice
Cloud Layer	Single, Multiple

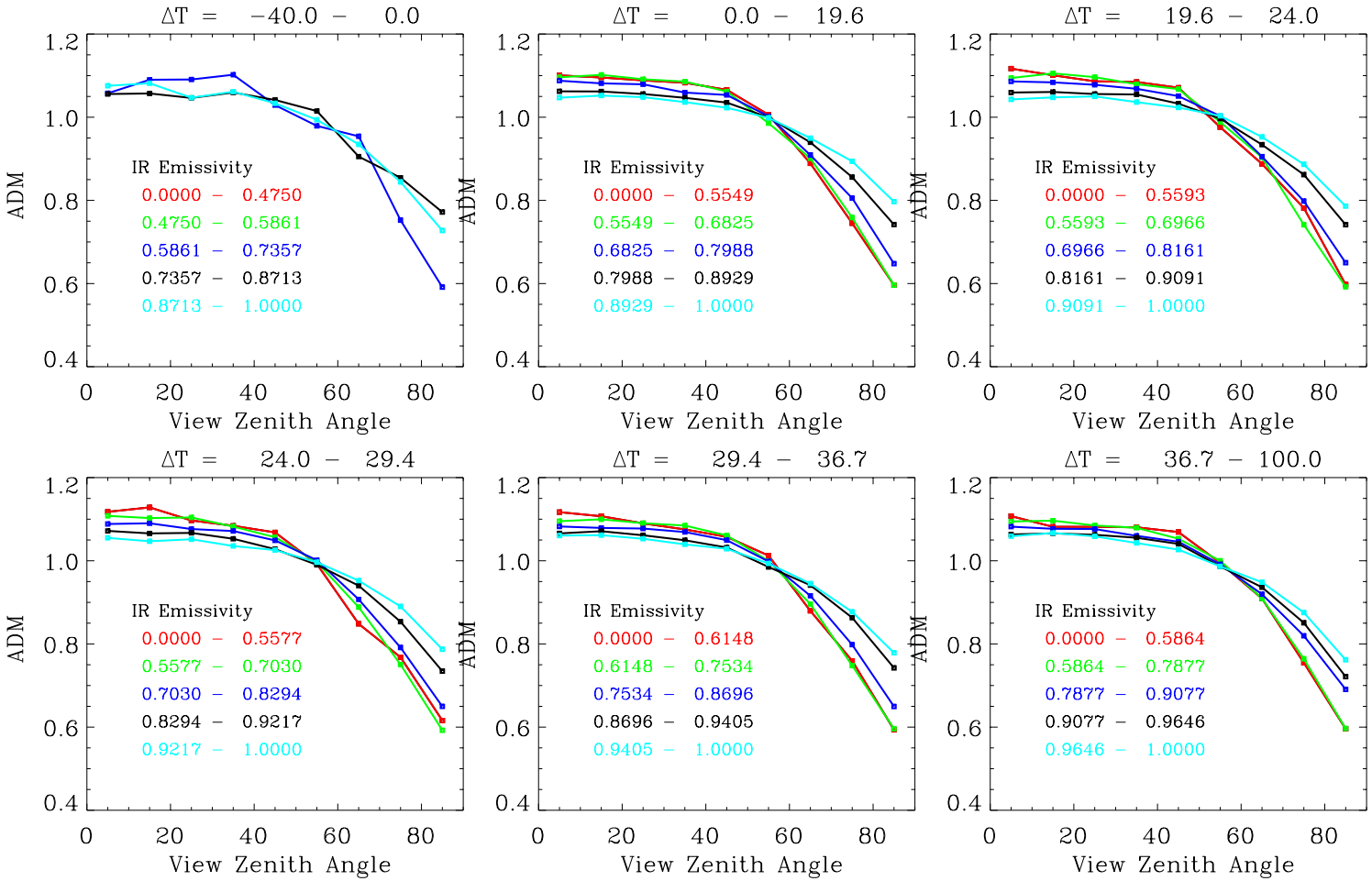
Potential CERES Longwave and Window ADM Scene Types (continued)

IR Emissivity	0-5,5-10,10-25,25-50,50-75,>75
Surface-Cloud Effective Temp	<0,0-20,20-40,40-60,60-80,>80 Percentile Intervals
Vertical Temperature Change	<0,0-20,20-40,40-60,60-80,>80 Percentile Intervals
LW/WN Surface Emittance	

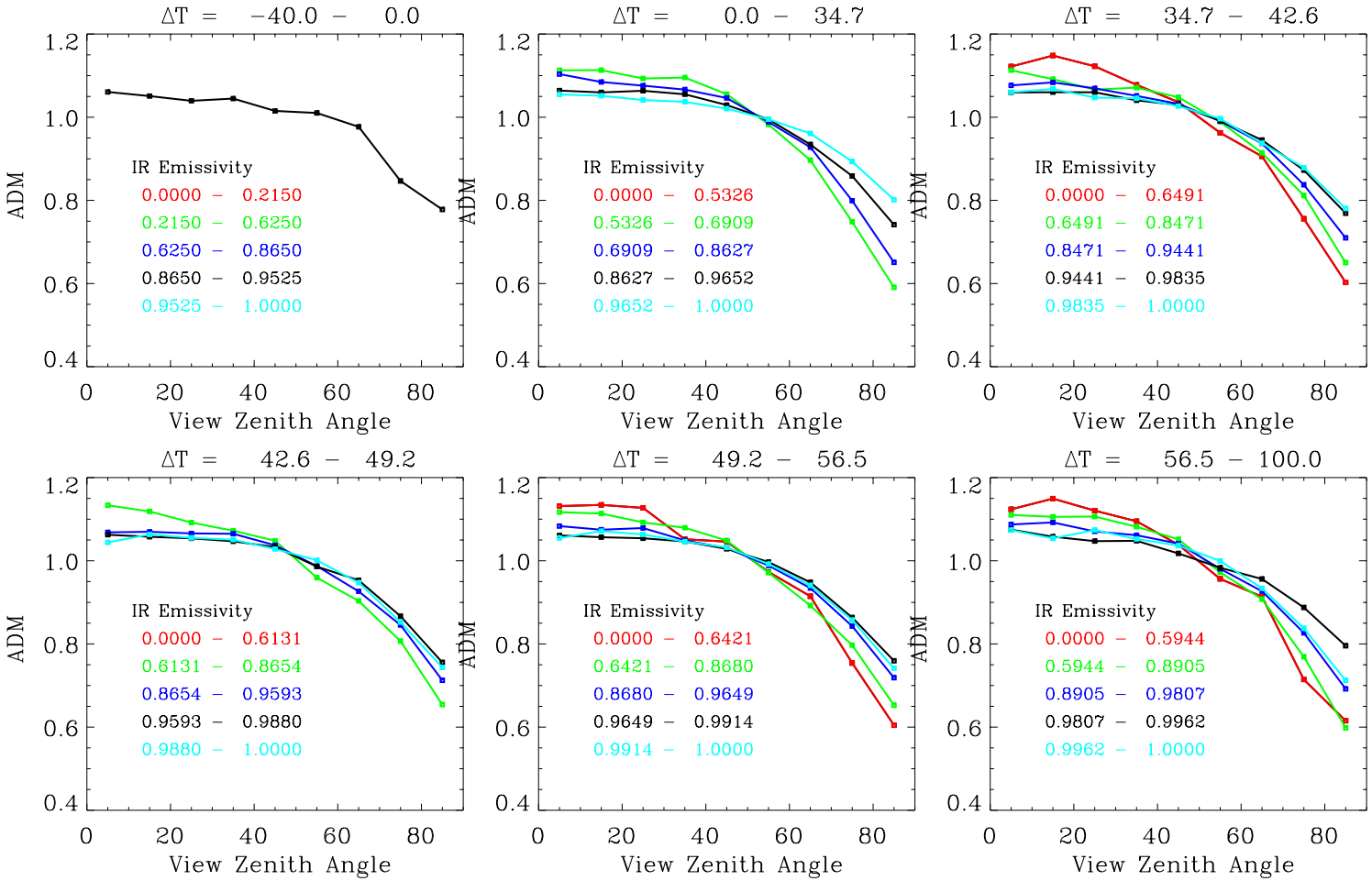
Variation of Overcast (Ocean) LW ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, Phase, & IR Emissivity
January − August 1998 − DAY RAPS/AT Only
Precipitable Water: 0.0000 − 2.3990 Water Clouds



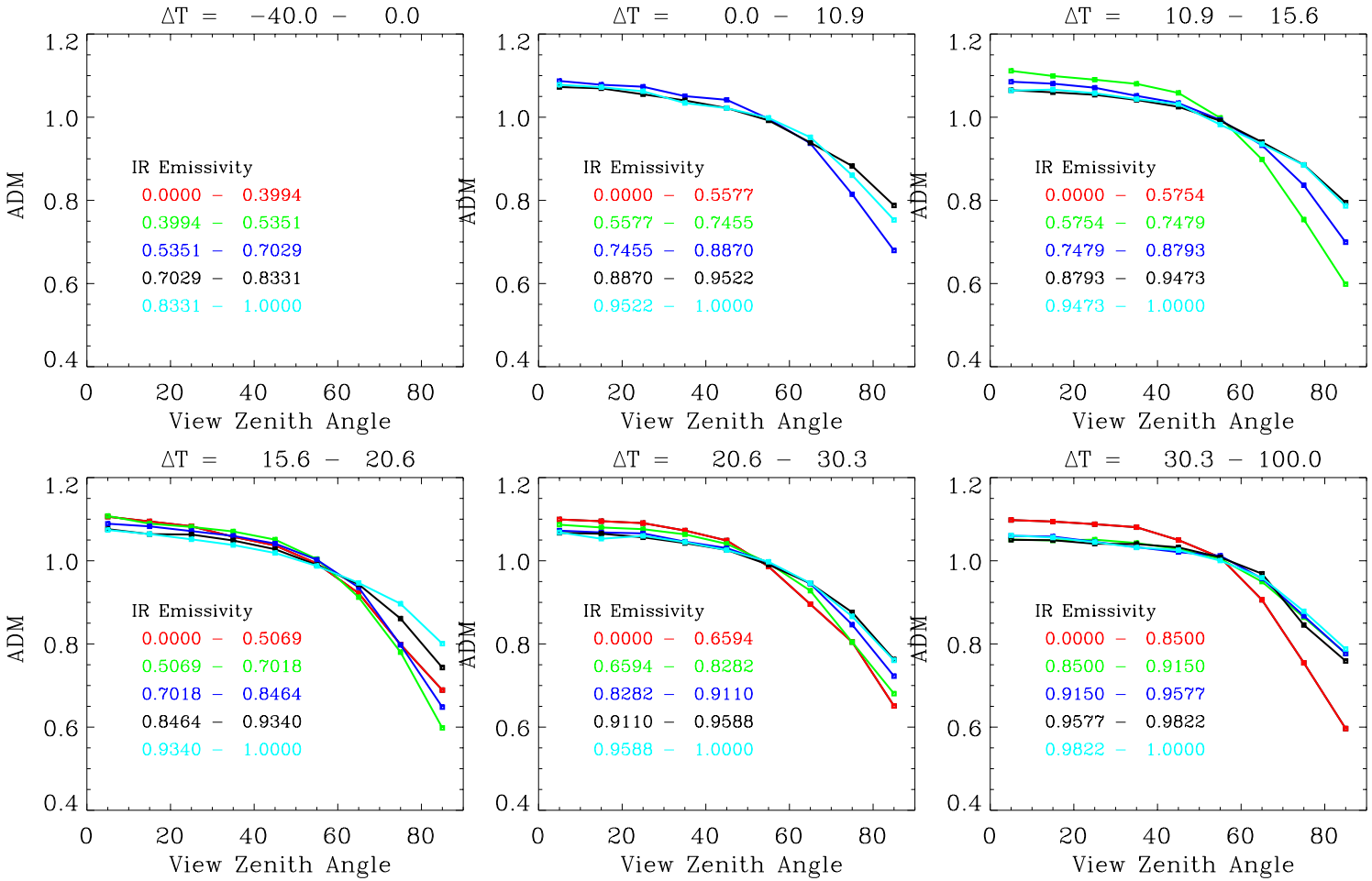
Variation of Overcast (Ocean) LW ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, Phase, & IR Emissivity
January – August 1998 – DAY RAPS/AT Only
Precipitable Water: 0.0000 – 2.3990 Water/Ice Clouds



Variation of Overcast (Ocean) LW ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, Phase, & IR Emissivity
January − August 1998 − DAY RAPS/AT Only
Precipitable Water: 0.0000 − 2.3990 Ice Clouds



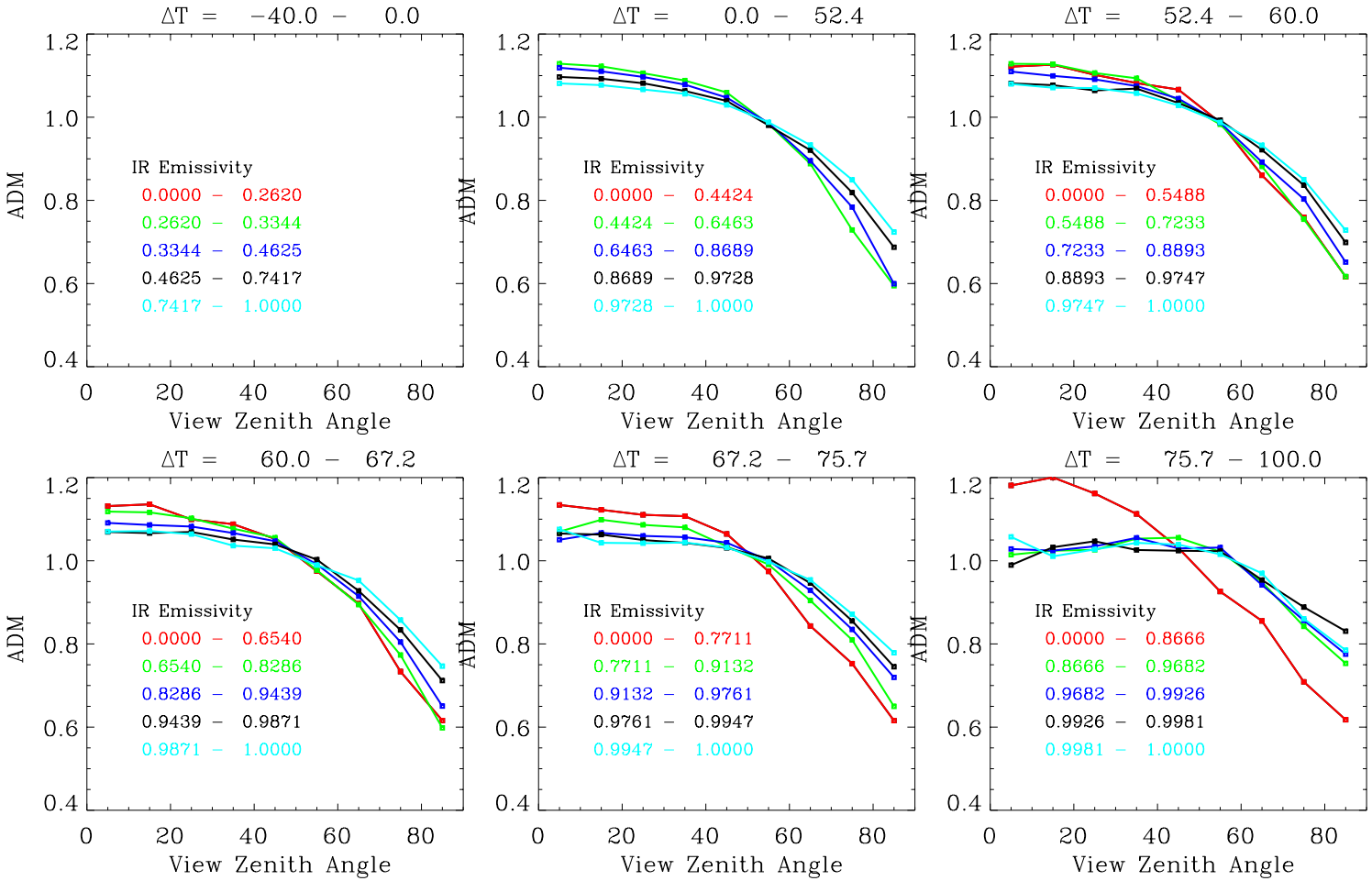
Variation of Overcast (Ocean) LW ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, Phase, & IR Emissivity
January − August 1998 − DAY RAPS/AT Only
Precipitable Water: 4.5680 − 10.0000 Water Clouds



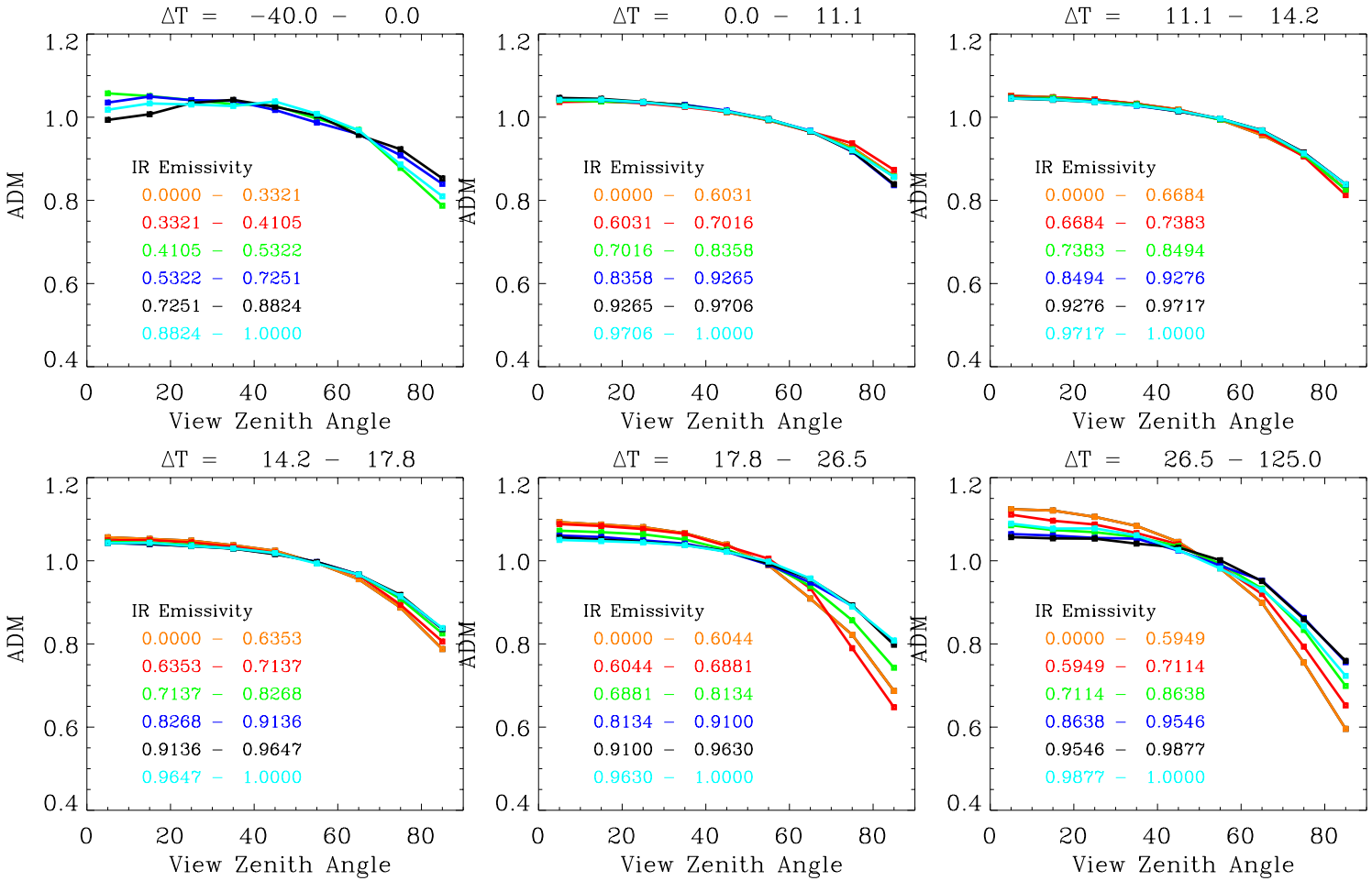
Variation of Overcast (Ocean) LW ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, Phase, & IR Emissivity

January – August 1998 – DAY RAPS/AT Only

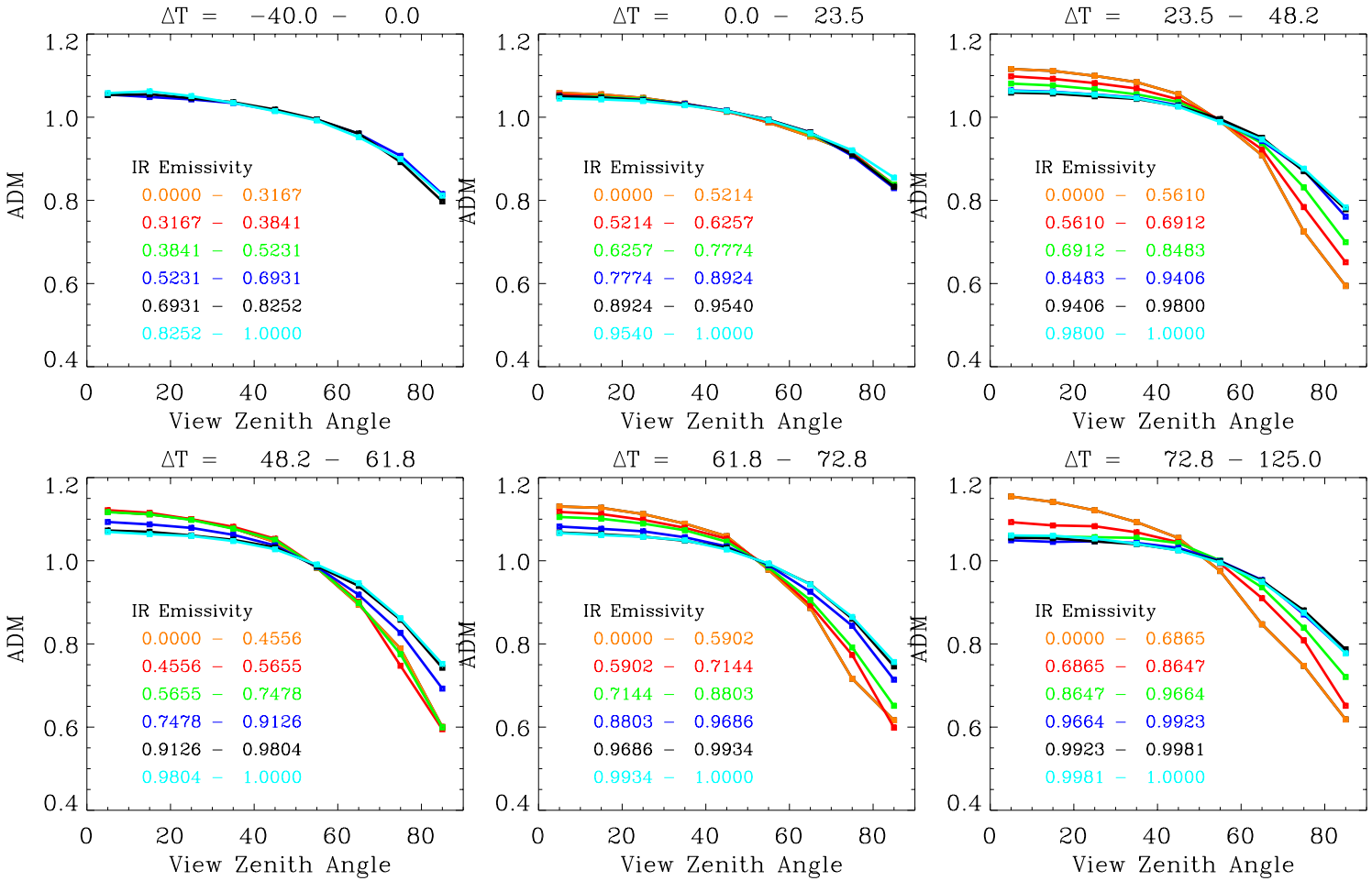
Precipitable Water: 4.5680 – 10.0000 Ice Clouds



Variation of Overcast (SLC – Ocean) LW ADM (Gupta TM) with
ΔT(Sfc–Cloud Eff. Temp), PW, & IR Emissivity
January – August 1998 – DAY RAPS/AT Only
Precipitable Water: 0.0000 – 2.2327



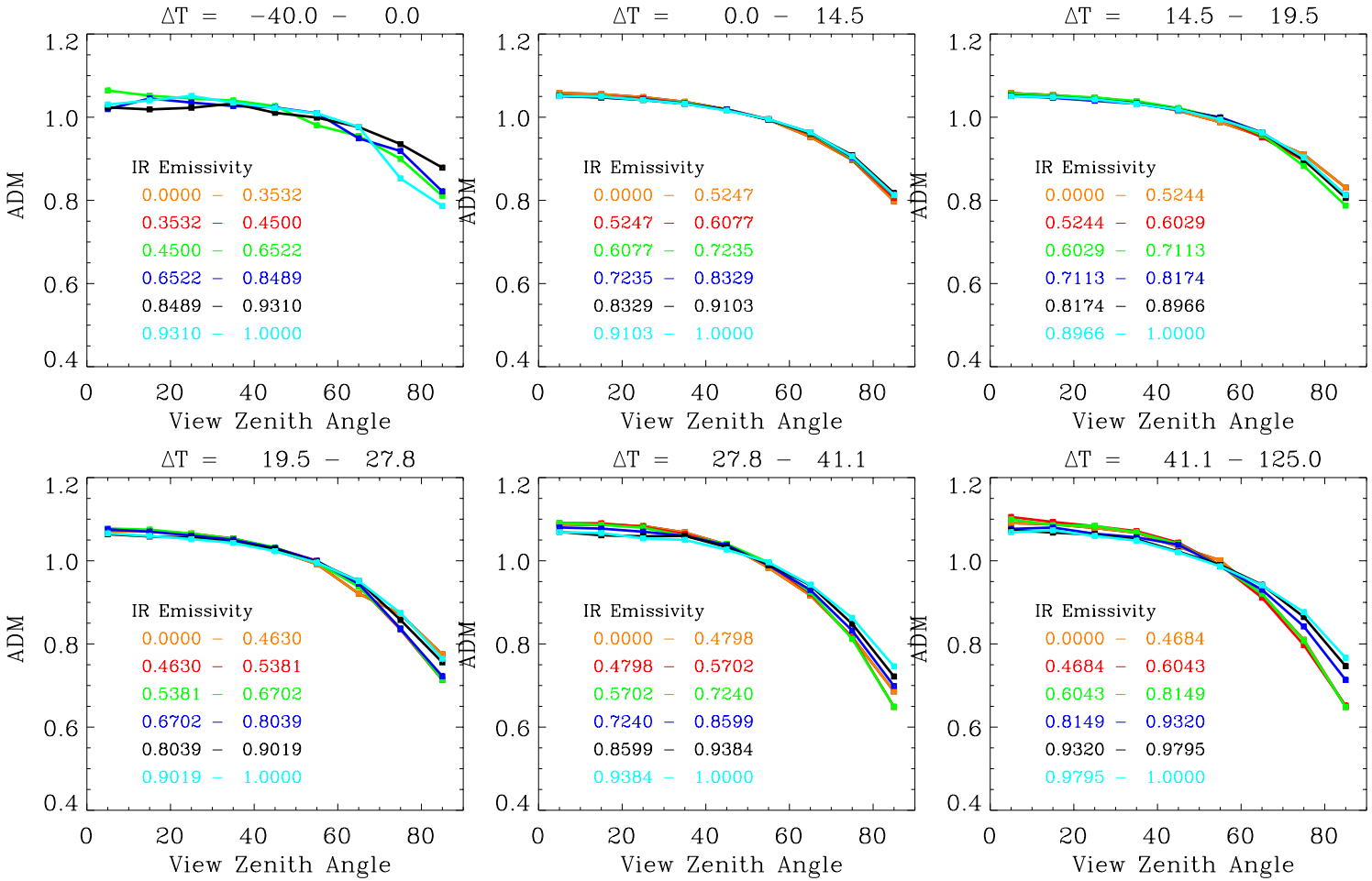
Variation of Overcast (SLC – Ocean) LW ADM (Gupta TM) with
ΔT(Sfc–Cloud Eff. Temp), PW, & IR Emissivity
January – August 1998 – DAY RAPS/AT Only
Precipitable Water: 4.2249 – 10.0000



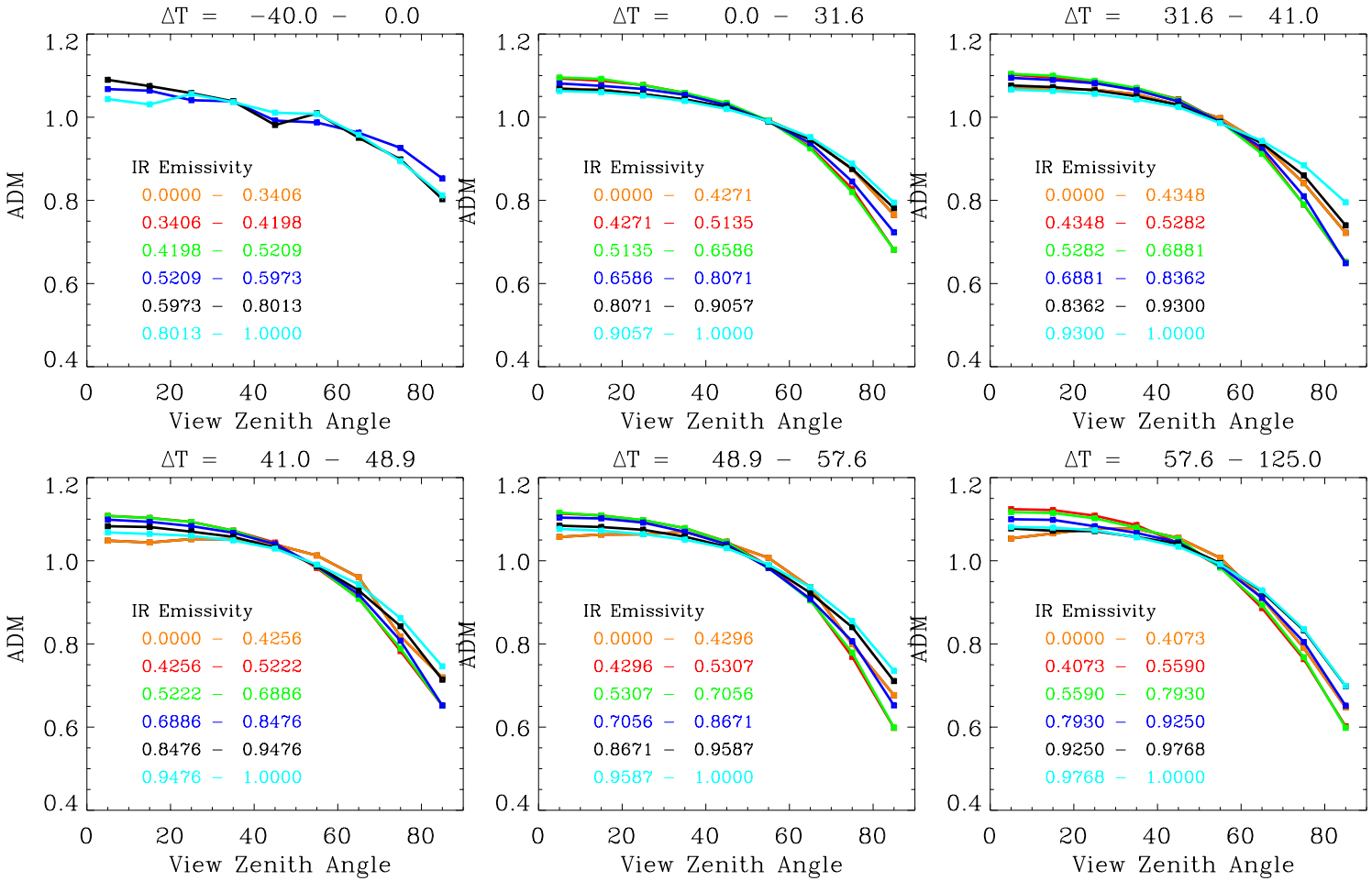
Variation of Overcast (MLC – Ocean) LW ADM (Gupta TM) with
ΔT(Sfc–Cloud Eff. Temp), PW, & IR Emissivity

January – August 1998 – DAY RAPS/AT Only

Precipitable Water: 0.0000 – 2.6618



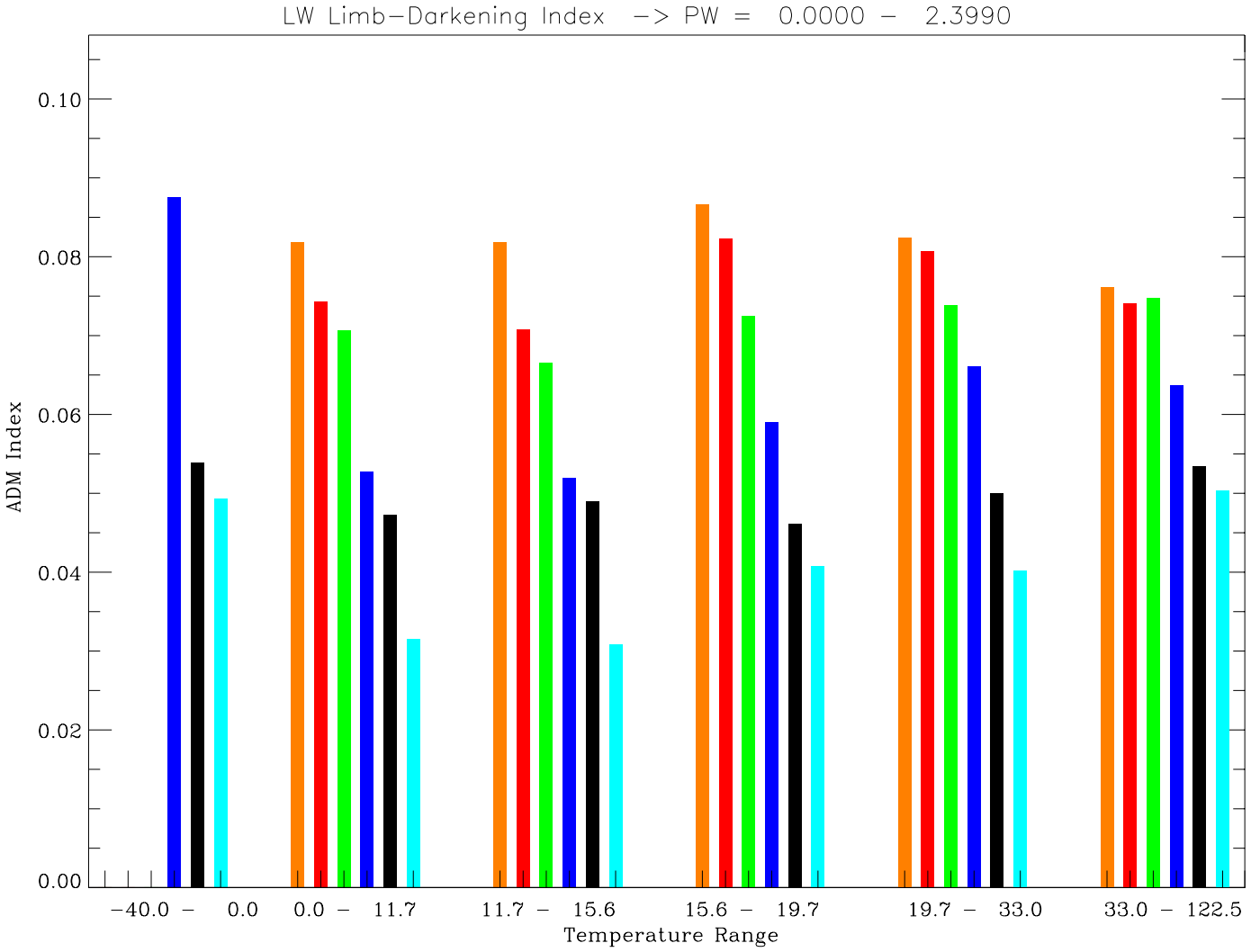
Variation of Overcast (MLC – Ocean) LW ADM (Gupta TM) with
ΔT(Sfc–Cloud Eff. Temp), PW, & IR Emissivity
January – August 1998 – DAY RAPS/AT Only
Precipitable Water: 4.9836 – 10.0000

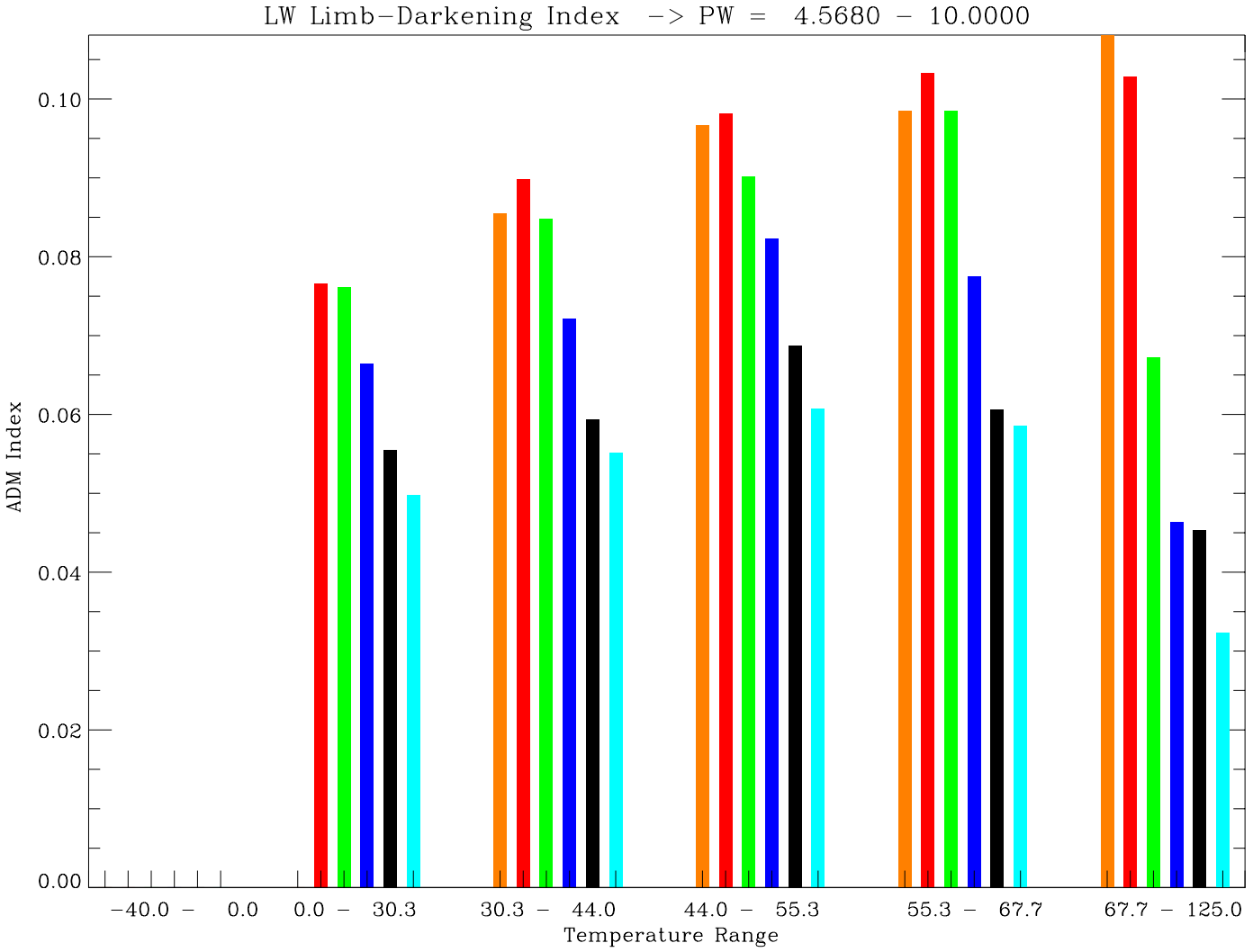


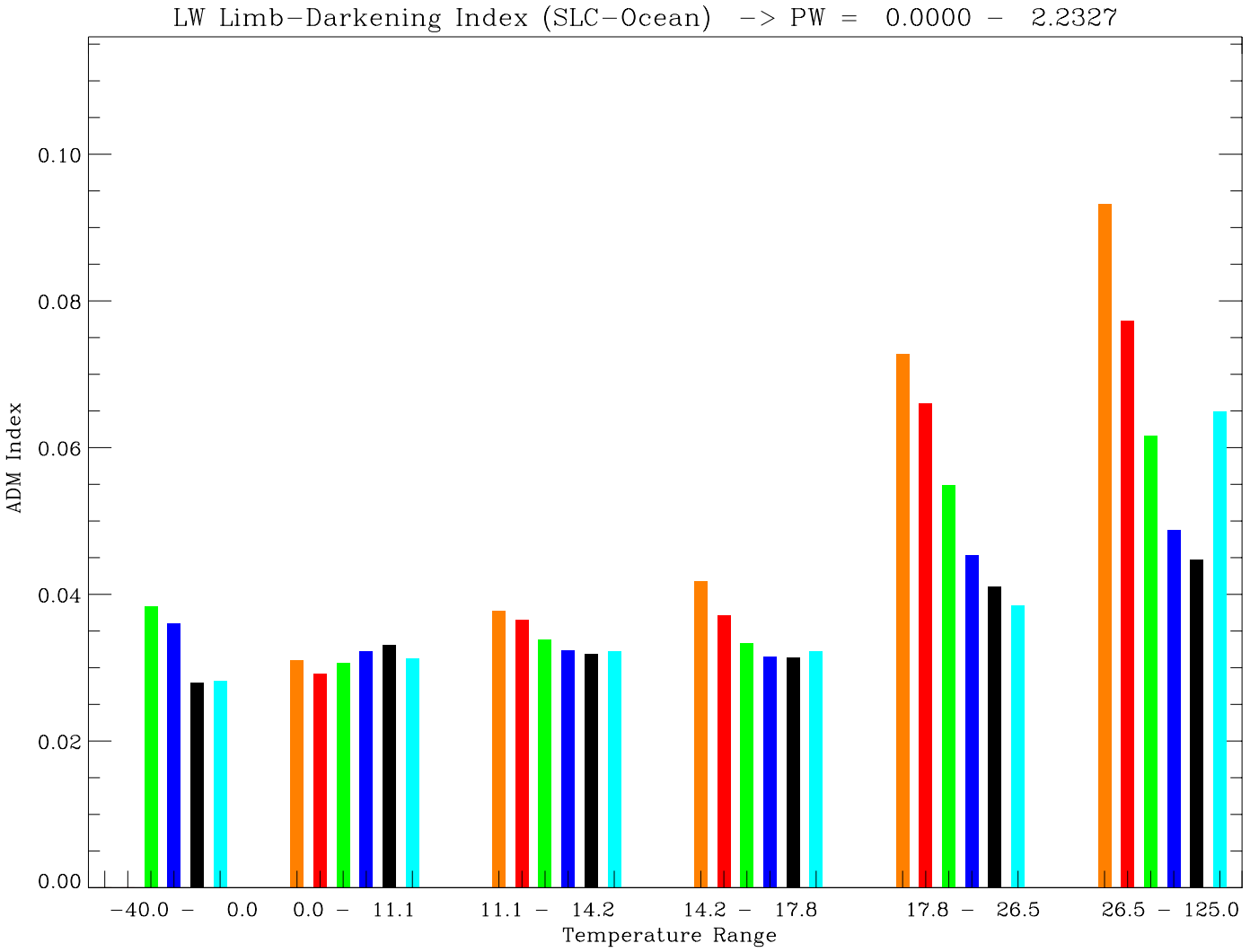
ERROR INDEX PLOTS for

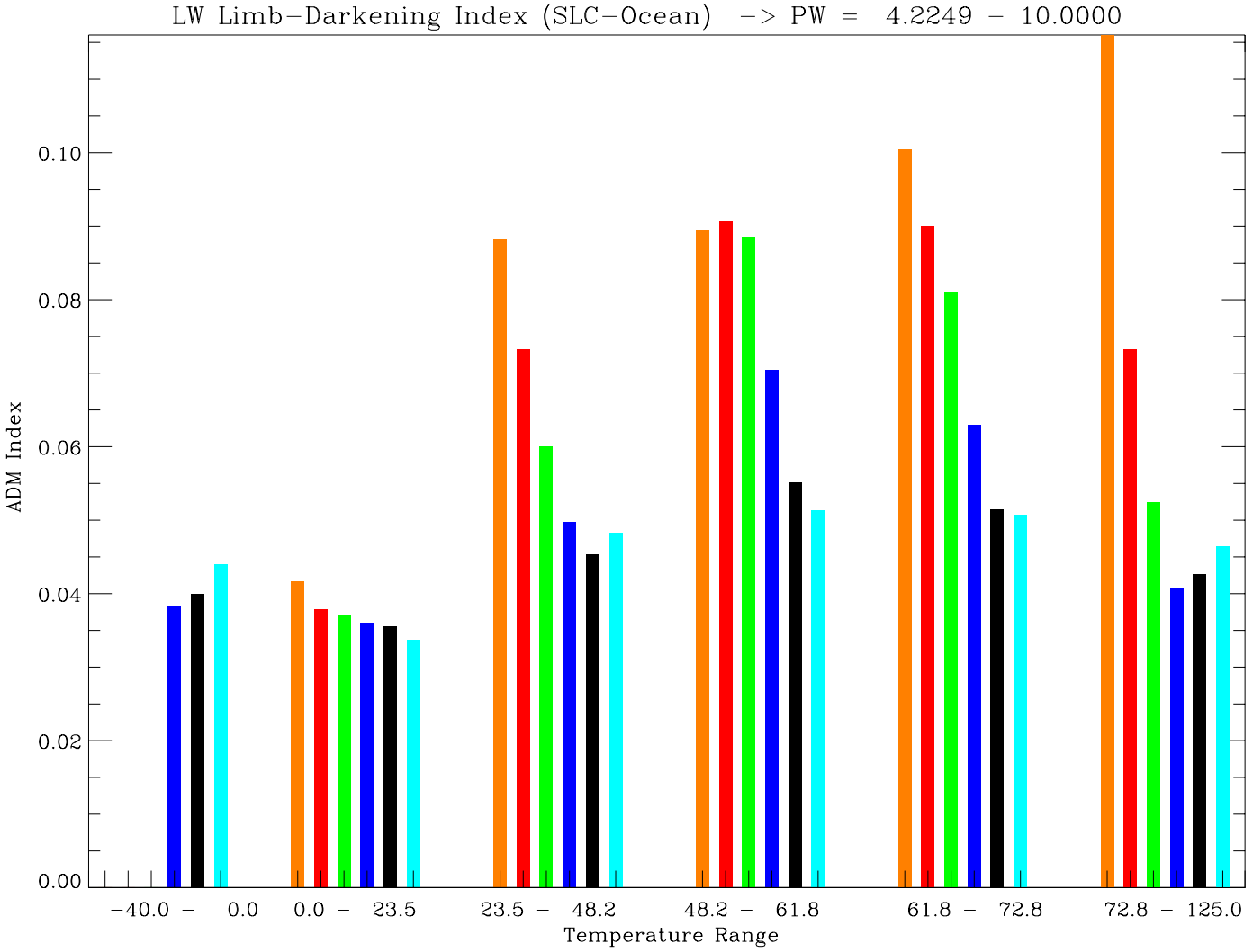
Overcast Case - No Cloud Layer Phase Disitinction for
PW = 0.0 - 2.399 and PW = 4.568 - 10

Single Layer Cloud Case


LW Limb−Darkening Index −> PW = 0.0000 − 2.3990
ADM Index
0.00
0.02
0.04
0.06
0.08
0.10
−40.0 − 0.0
0.0 − 11.7
11.7 − 15.6
15.6 − 19.7
19.7 − 33.0
33.0 − 122.5
Temperature Range


LW Limb−Darkening Index −> PW = 4.5680 − 10.0000
ADM Index
0.00
0.02
0.04
0.06
0.08
0.10
−40.0 − 0.0
0.0 − 30.3
30.3 − 44.0
44.0 − 55.3
55.3 − 67.7
67.7 − 125.0
Temperature Range


LW Limb-Darkening Index (SLC-Ocean) -> PW = 0.0000 - 2.2327
ADM Index
0.00
0.02
0.04
0.06
0.08
0.10
-40.0 - 0.0
0.0 - 11.1
11.1 - 14.2
14.2 - 17.8
17.8 - 26.5
26.5 - 125.0
Temperature Range


LW Limb-Darkening Index (SLC-Ocean) -> PW = 4.2249 - 10.0000
ADM Index
0.00
0.02
0.04
0.06
0.08
0.10
-40.0 - 0.0
0.0 - 23.5
23.5 - 48.2
48.2 - 61.8
61.8 - 72.8
72.8 - 125.0
Temperature Range

Variation of Clear Sky ADMs with

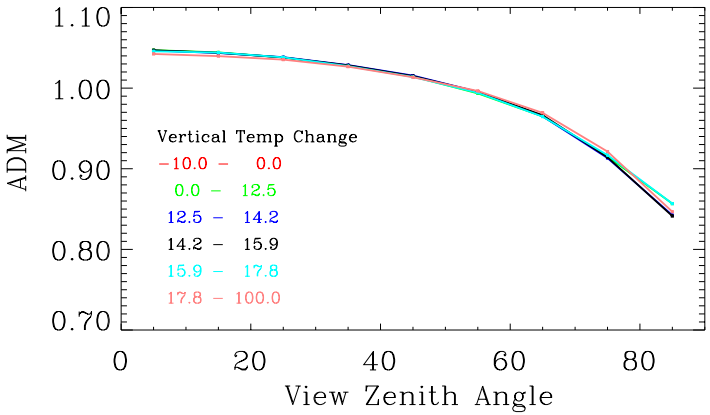
Precipitable Water

Vertical Temperature Change

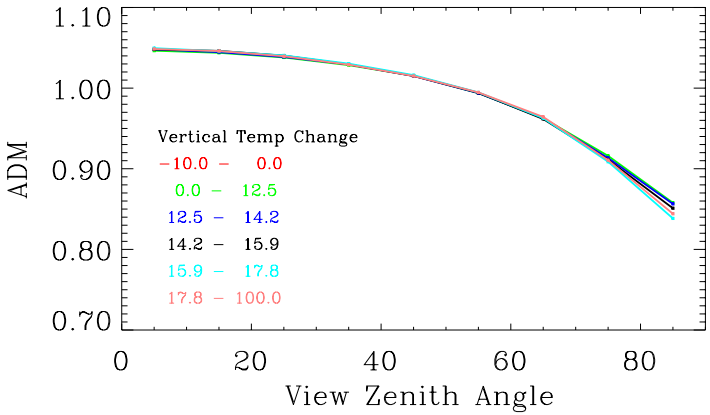
Surface Emissivity

Variation of Clear Sky (Ocean) LW ADM
with Vertical Temperature Change
January – August 1998 – DAY RAPS Only

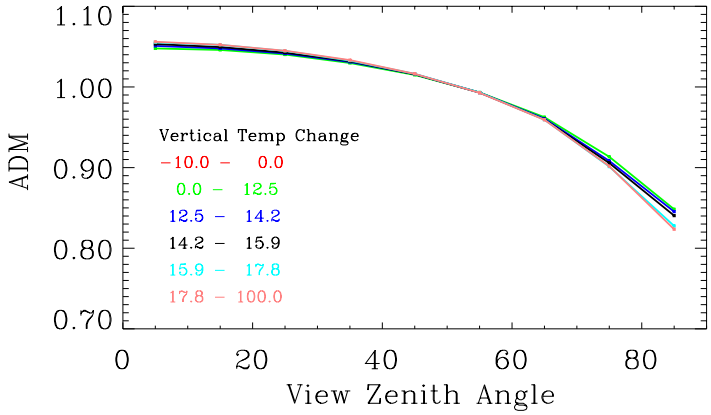
Precipitable Water: 0.0000 – 2.3182



Precipitable Water: 2.3182 – 3.5503



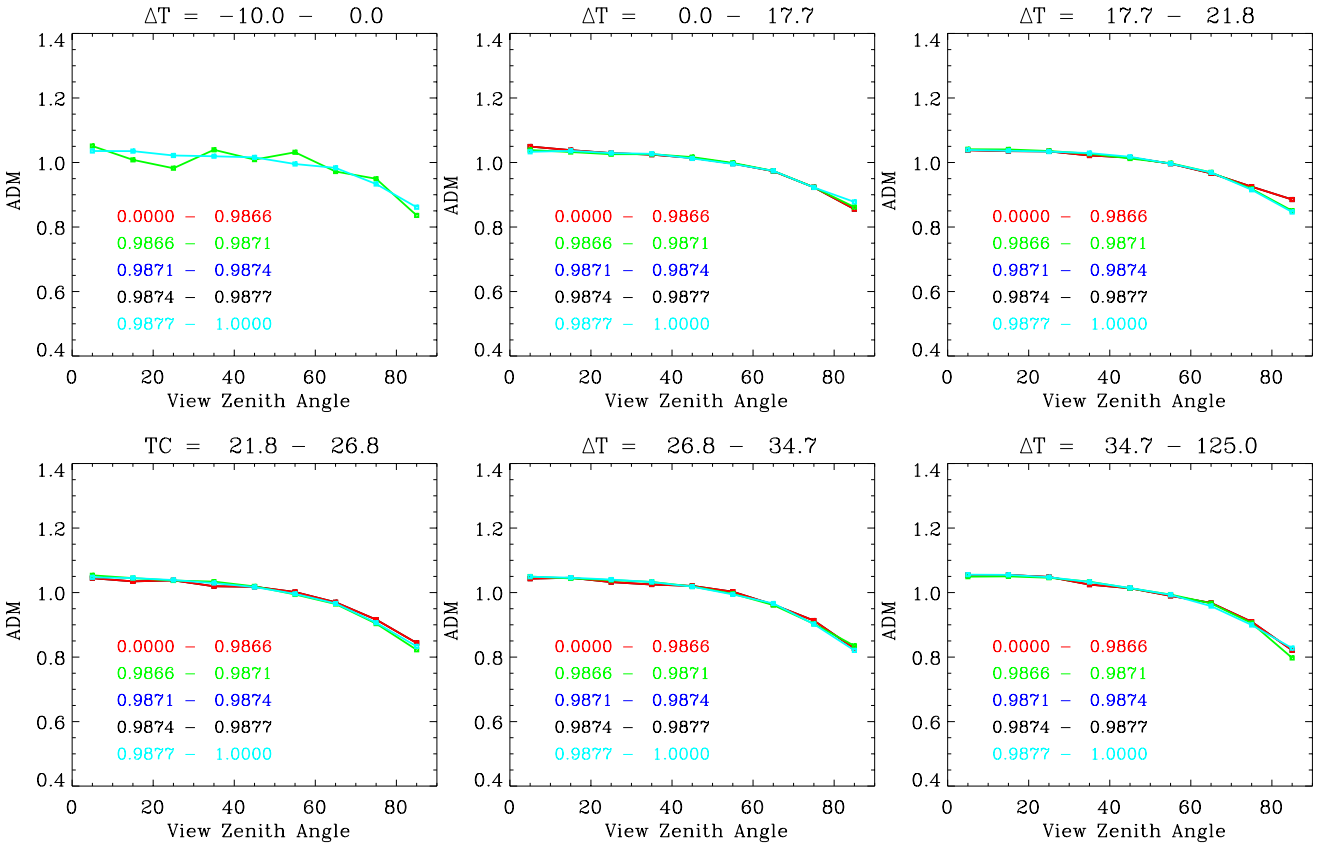
Precipitable Water: 3.5503 – 10.0000



[LW ADM (Clear Land) = f(PW, Vertical Temp. Change, SFC Emissivity)]

January – August 1998 – RAPS/AT (Day)

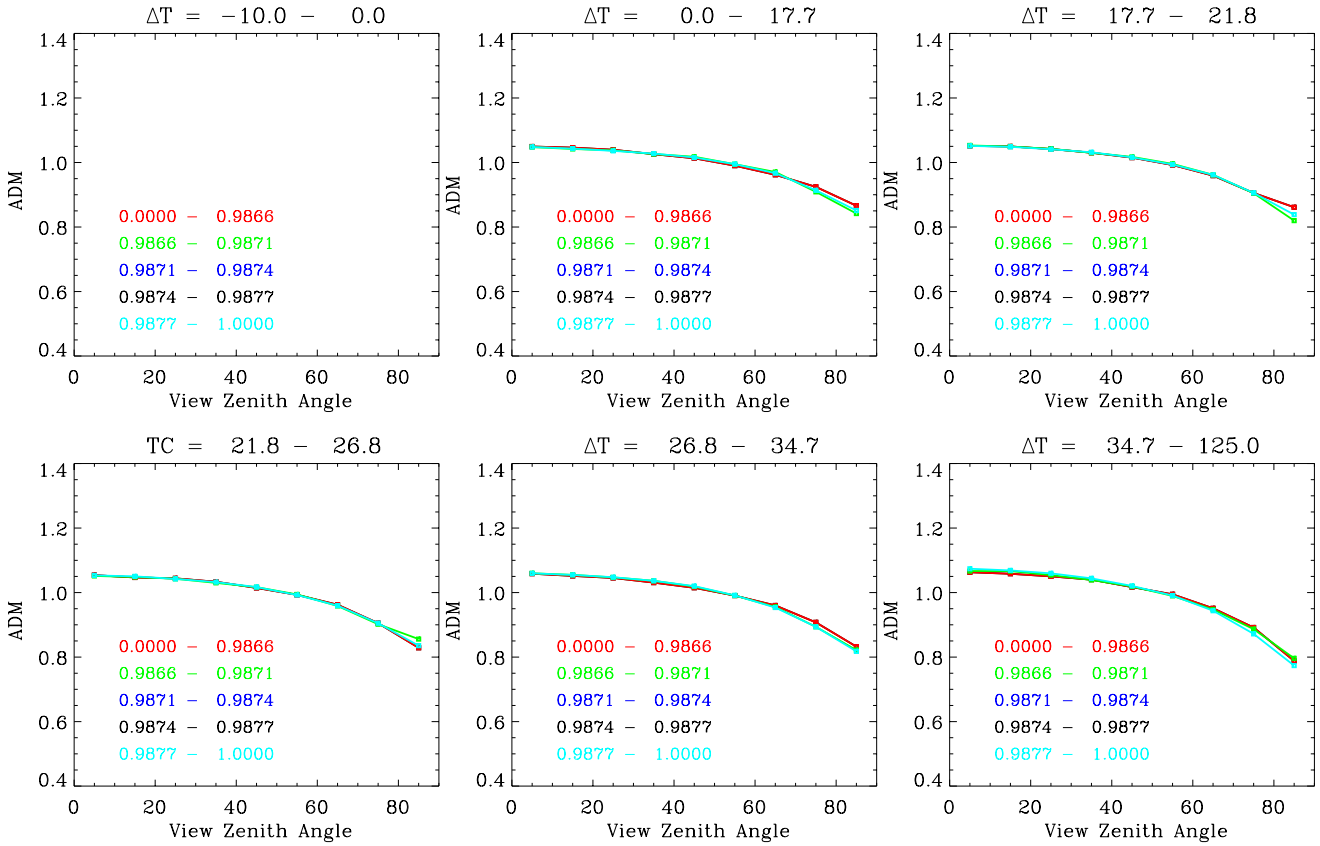
Precipitable Water: 0.0000 – 1.5289



[LW ADM (Clear Land) = f(PW, Vertical Temp. Change, SFC Emissivity)]

January – August 1998 – RAPS/AT (Day)

Precipitable Water: 2.9326 – 10.0000

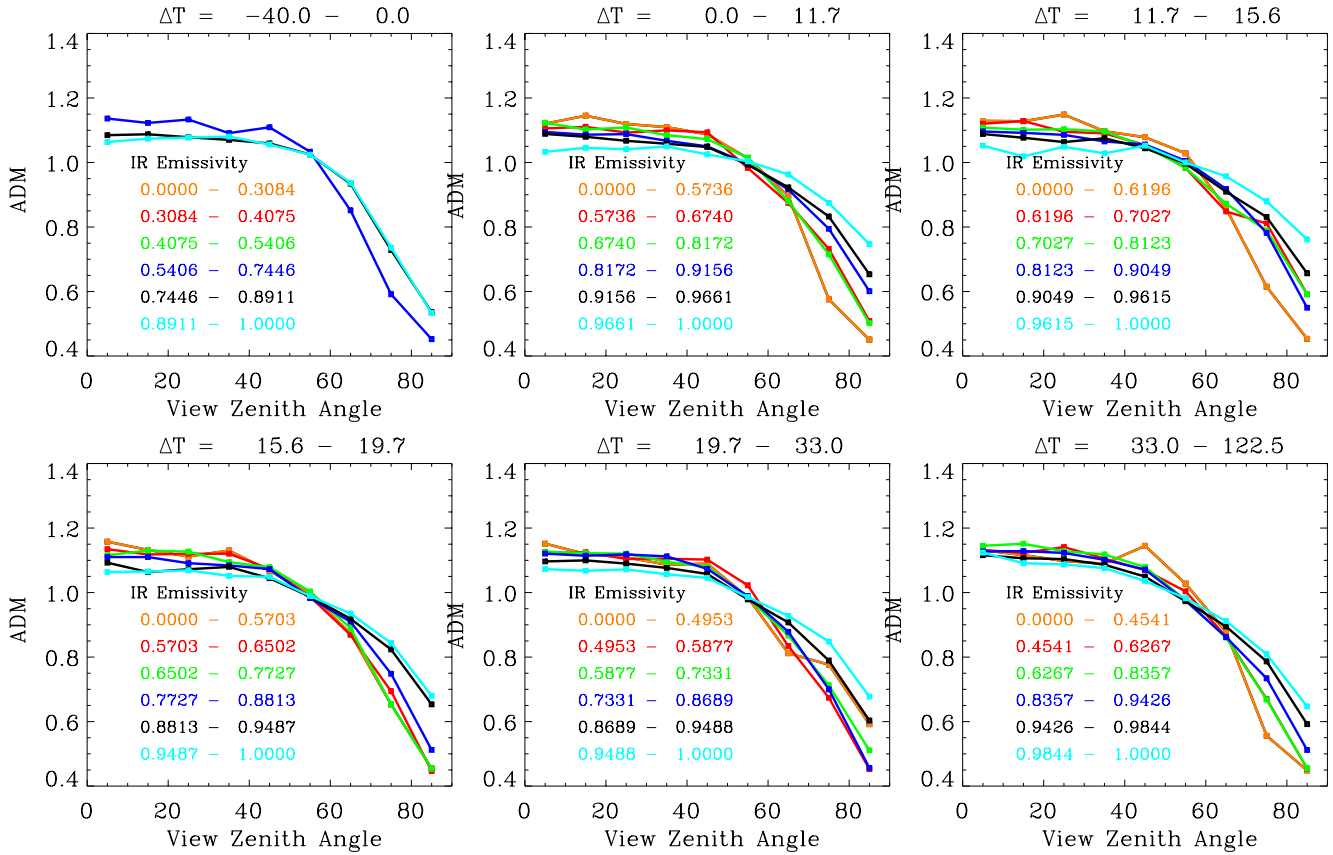


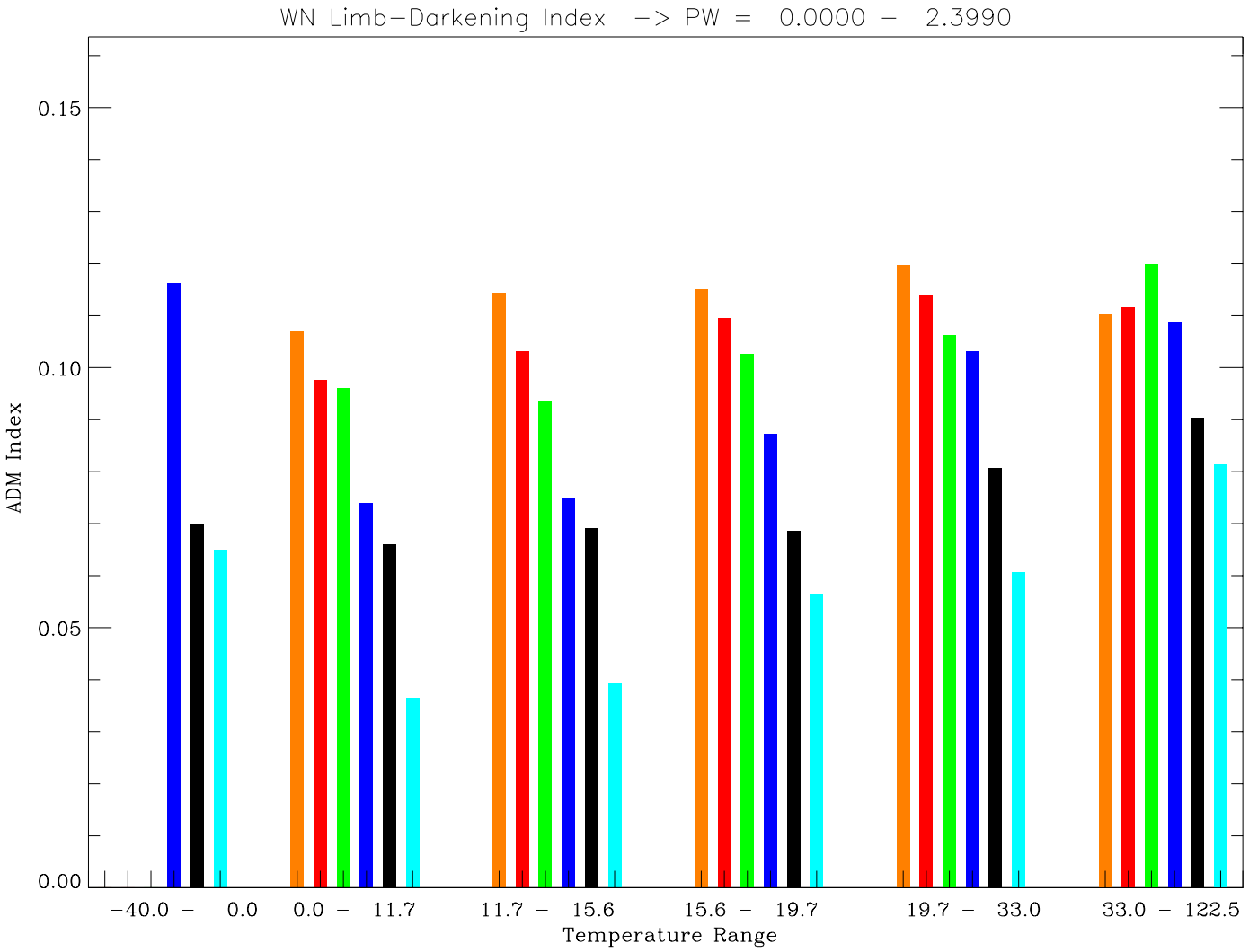
VARIATION OF WINDOW ADMS

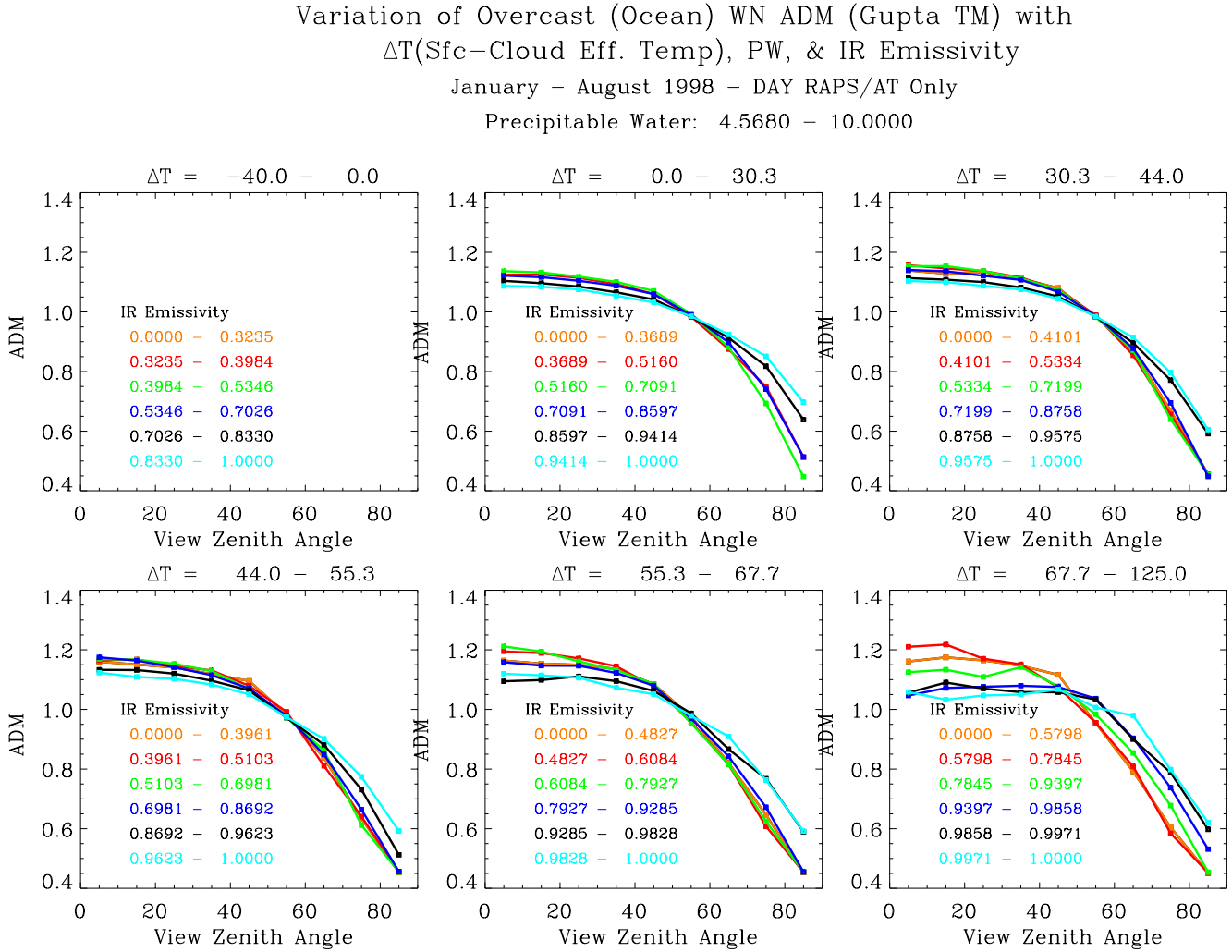
WITH PRECIPITABLE WATER,

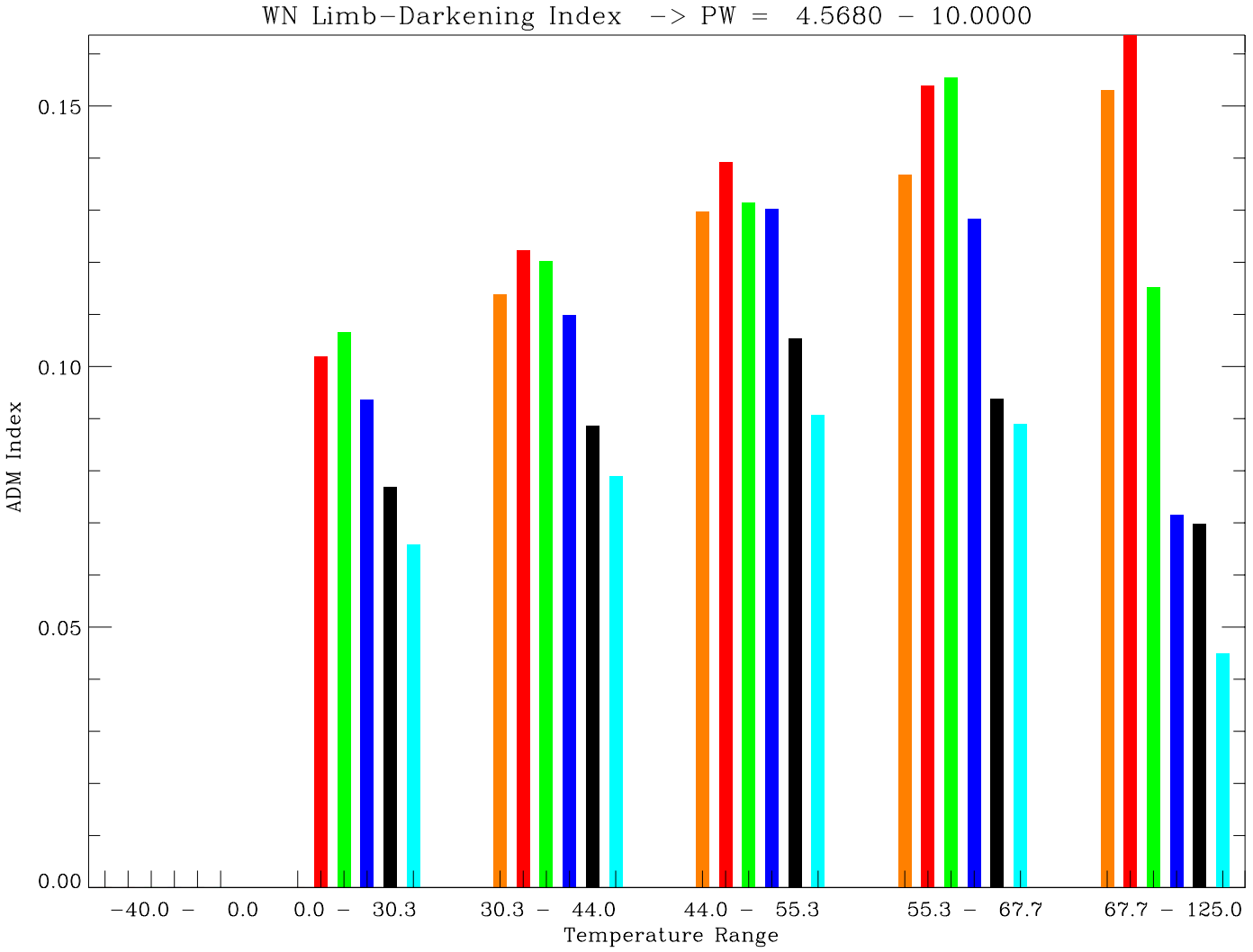
TEMPERATURE DIFFERENCE (SURFACE T - CLOUD EFFECTIVE T)

AND IR EMISSIVITY


Variation of Overcast (Ocean) WN ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, & IR Emissivity
January − August 1998 − DAY RAPS/AT Only
Precipitable Water: 0.0000 − 2.3990
ΔT = −40.0 − 0.0
ΔT = 0.0 − 11.7
ΔT = 11.7 − 15.6
ΔT = 15.6 − 19.7
ΔT = 19.7 − 33.0
ΔT = 33.0 − 122.5
ADM
View Zenith Angle
IR Emissivity
0.0000 − 0.3084
0.3084 − 0.4075
0.4075 − 0.5406
0.5406 − 0.7446
0.7446 − 0.8911
0.8911 − 1.0000
0.0000 − 0.5736
0.5736 − 0.6740
0.6740 − 0.8172
0.8172 − 0.9156
0.9156 − 0.9661
0.9661 − 1.0000
0.0000 − 0.6196
0.6196 − 0.7027
0.7027 − 0.8123
0.8123 − 0.9049
0.9049 − 0.9615
0.9615 − 1.0000
0.0000 − 0.5703
0.5703 − 0.6502
0.6502 − 0.7727
0.7727 − 0.8813
0.8813 − 0.9487
0.9487 − 1.0000
0.0000 − 0.4953
0.4953 − 0.5877
0.5877 − 0.7331
0.7331 − 0.8689
0.8689 − 0.9488
0.9488 − 1.0000
0.0000 − 0.4541
0.4541 − 0.6267
0.6267 − 0.8357
0.8357 − 0.9426
0.9426 − 0.9844
0.9844 − 1.0000


WN Limb−Darkening Index −> PW = 0.0000 − 2.3990
ADM Index
0.00
0.05
0.10
0.15
−40.0 − 0.0
0.0 − 11.7
11.7 − 15.6
15.6 − 19.7
19.7 − 33.0
33.0 − 122.5
Temperature Range

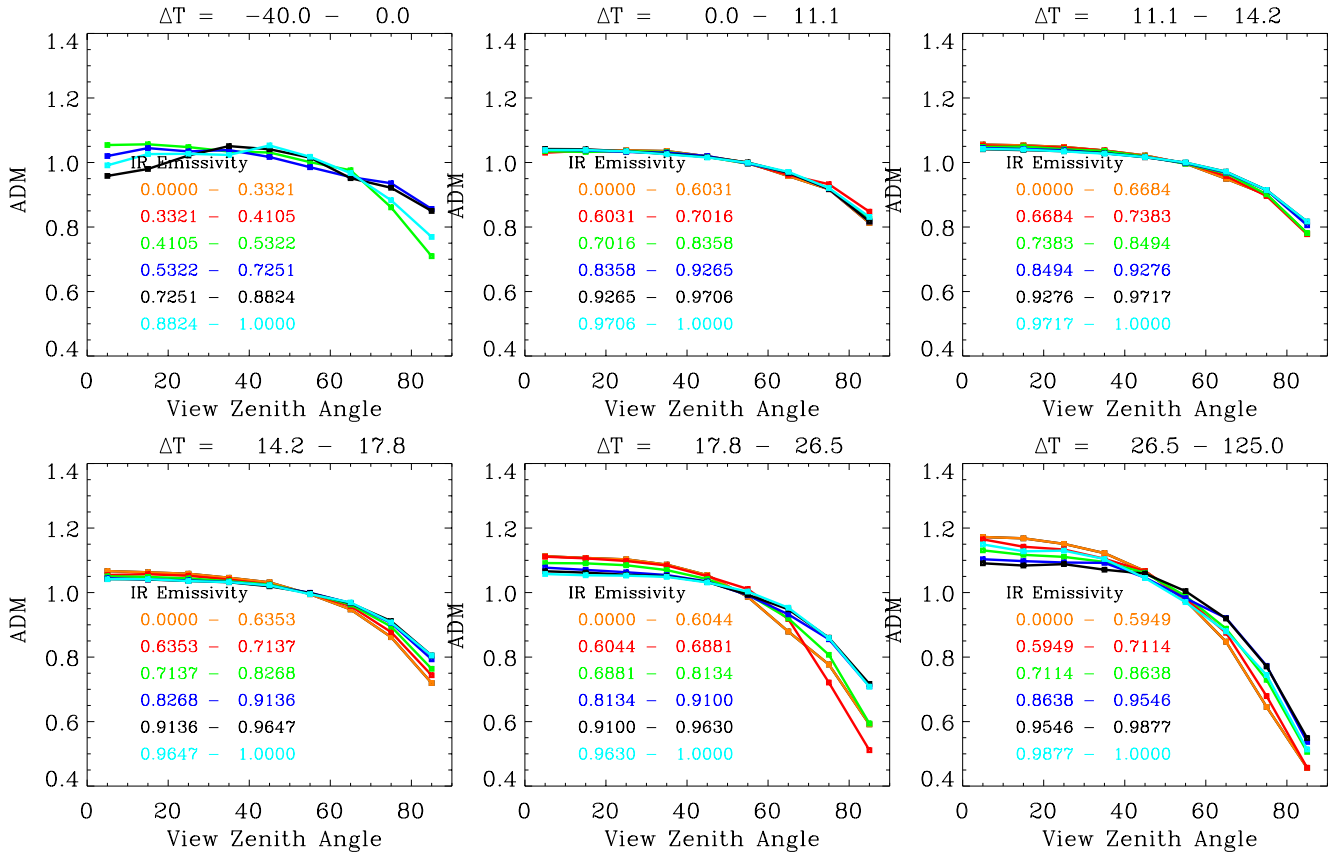

Variation of Overcast (Ocean) WN ADM (Gupta TM) with
ΔT(Sfc−Cloud Eff. Temp), PW, & IR Emissivity
January − August 1998 − DAY RAPS/AT Only
Precipitable Water: 4.5680 − 10.0000
ΔT = −40.0 − 0.0
IR Emissivity
0.0000 − 0.3235
0.3235 − 0.3984
0.3984 − 0.5346
0.5346 − 0.7026
0.7026 − 0.8330
0.8330 − 1.0000
ΔT = 0.0 − 30.3
IR Emissivity
0.0000 − 0.3689
0.3689 − 0.5160
0.5160 − 0.7091
0.7091 − 0.8597
0.8597 − 0.9414
0.9414 − 1.0000
ΔT = 30.3 − 44.0
IR Emissivity
0.0000 − 0.4101
0.4101 − 0.5334
0.5334 − 0.7199
0.7199 − 0.8758
0.8758 − 0.9575
0.9575 − 1.0000
ΔT = 44.0 − 55.3
IR Emissivity
0.0000 − 0.3961
0.3961 − 0.5103
0.5103 − 0.6981
0.6981 − 0.8692
0.8692 − 0.9623
0.9623 − 1.0000
ΔT = 55.3 − 67.7
IR Emissivity
0.0000 − 0.4827
0.4827 − 0.6084
0.6084 − 0.7927
0.7927 − 0.9285
0.9285 − 0.9828
0.9828 − 1.0000
ΔT = 67.7 − 125.0
IR Emissivity
0.0000 − 0.5798
0.5798 − 0.7845
0.7845 − 0.9397
0.9397 − 0.9858
0.9858 − 0.9971
0.9971 − 1.0000
ADM
View Zenith Angle
0
20
40
60
80
0.4
0.6
0.8
1.0
1.2
1.4


WN Limb-Darkening Index -> PW = 4.5680 - 10.0000
ADM Index
0.00
0.05
0.10
0.15
-40.0 - 0.0
0.0 - 30.3
30.3 - 44.0
44.0 - 55.3
55.3 - 67.7
67.7 - 125.0
Temperature Range

Variation of Overcast (SLC – Ocean) WN ADM (Gupta TM) with
ΔT(Sfc–Eff. Temp), PW, & IR Emissivity

January – August 1998 – DAY RAPS/AT Only

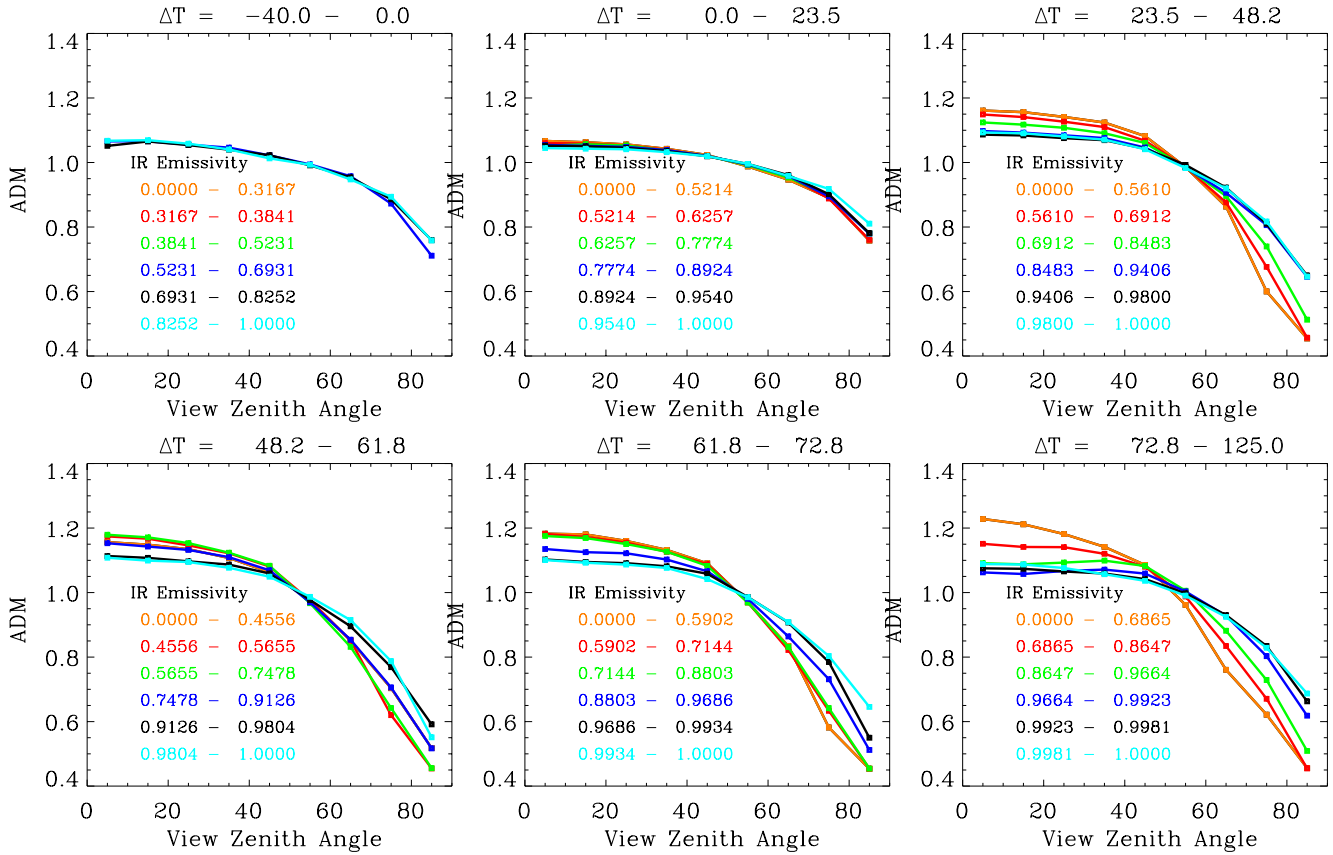
Precipitable Water: 0.0000 – 2.2327



Variation of Overcast (SLC – Ocean) WN ADM (Gupta TM) with
ΔT(Sfc–Eff. Temp), PW, & IR Emissivity

January – August 1998 – DAY RAPS/AT Only

Precipitable Water: 4.2249 – 10.0000



Variation of LW Overcast ADMs with Cloud Optical Depth and Cloud Height

- Stratified single layer tropical overcast clouds into:

  Cloud Height (0-3,3-6,6-10,10-15,>15 km)
  Cloud Optical Depth (0.3-2.5, 2.5-6, 6-10, 10-18, 18-40, 40-100)
  Water, Ice Cloud Particle Phase

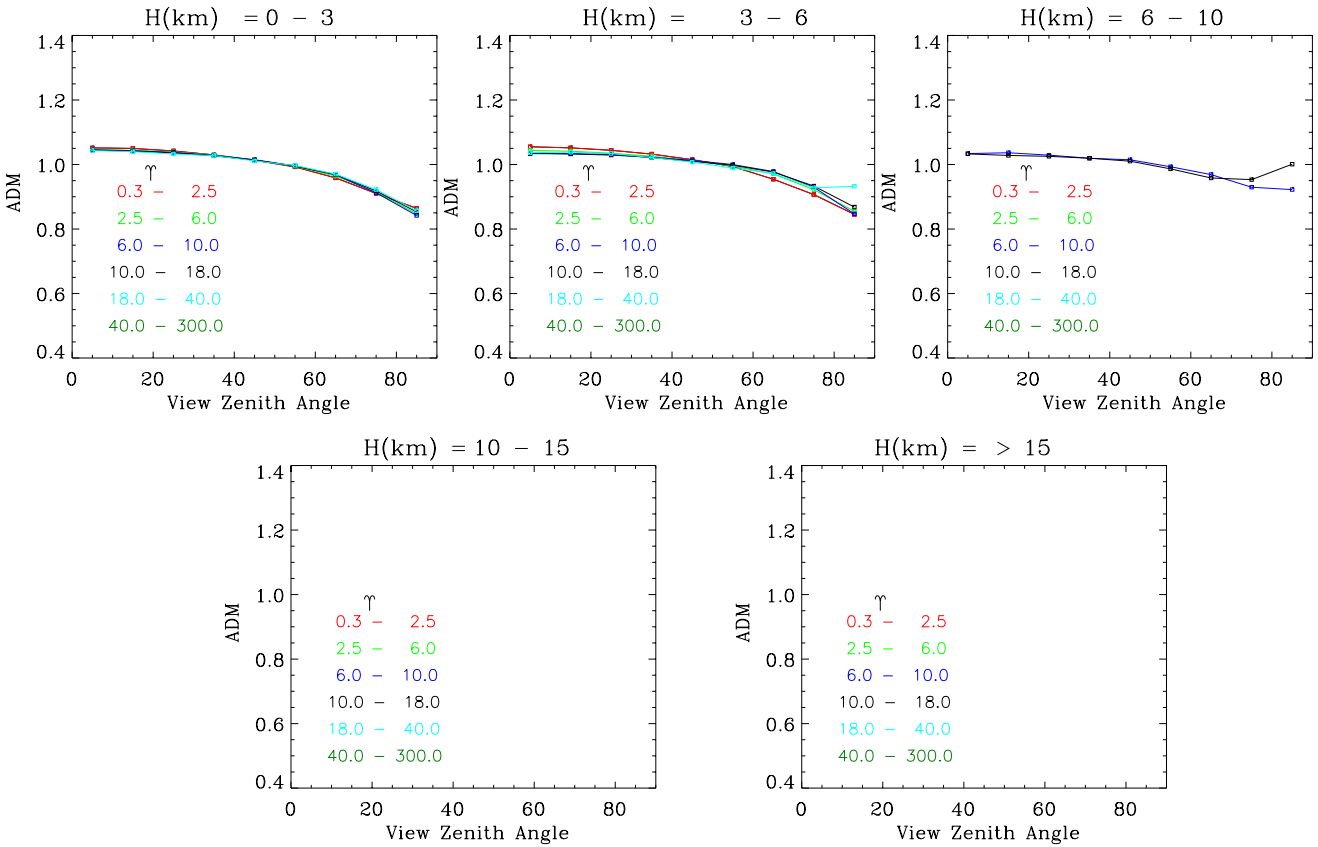
- Results

  Midlevel clouds exhibit differences in anisotropy due to phase with water clouds less anisotropic (R=1.025) than ice clouds (R=1.04).

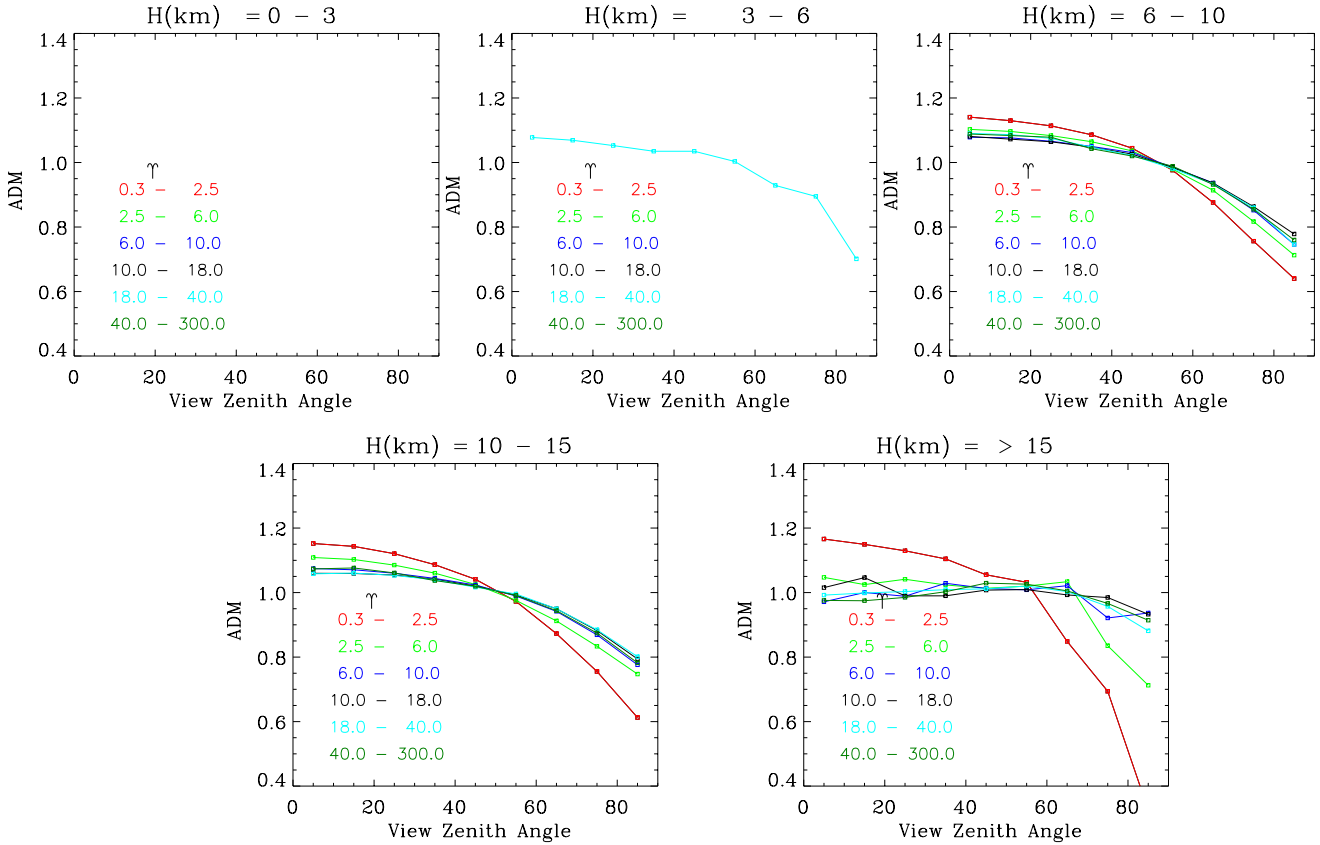
  For ice clouds, a dramatic change from cloud heights <15 km (R=1.03) is observed with cloud heights >15 km (R~1.0).

  Water Cloud ADMs do not show significant variation with cloud optical depth. Ice cloud ADMs show variations due to cloud height and optical depth (thin clouds more anisotropic than thick clouds).

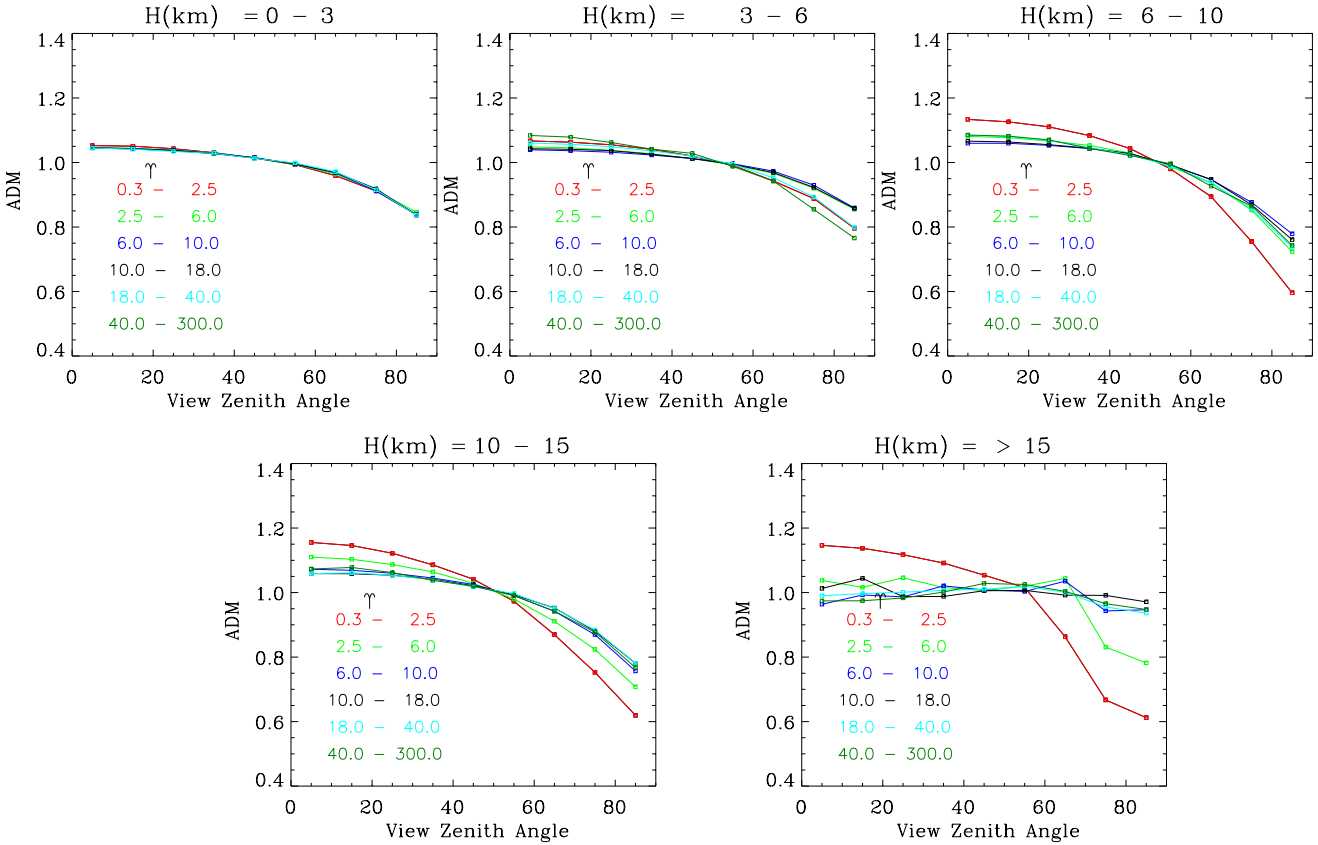
[LW ADM (Single Layer Water Clouds) = f(Optical Depth, Cloud Height)]
Jan – Aug 1998 – RAPS (Day/Tropical)



[LW ADM (Single Layer Ice Clouds) = f(Optical Depth, Cloud Height)]
Jan – Aug 1998 – RAPS (Day/Tropical)



[LW ADM (Single Layer Clouds – Gupta–corr) = f(Optical Depth, Cloud Height)]
Jan – Aug 1998 – RAPS (Day/Tropical)



SUMMARY/FUTURE WORK

- ADMs show more variation with IR emissivity than with precipitable water and temperature differences between the surface T and the effective cloud T.
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- IR emissivity variation with ADMs are generally more significant for ice cloud layer phase than for water cloud layer phase for single and multiple layer cases.
-
- The variation of ADMs with PW, IR emissivity and Temperature Difference (surface T - cloud effective T) will be investigated for special overcast cases (e.g. deep convective cloud case)
-
- The variation of broken cloud ADMs with various cloud and atmosphere parameters will be studied.